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Kiani

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(54) **VIRTUAL DISPLAY**

(75) Inventor: **Massi E. Kiani**, Laguna Niguel, CA (US)

(73) Assignee: **Masimo Corporation**, Irvine, CA (US)

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G06T 17/00 (2006.01)

(52) **U.S. Cl.** **345/440**; 345/582; 345/619; 345/629; 345/689; 345/699

(58) **Field of Classification Search** .... None
See application file for complete search history.

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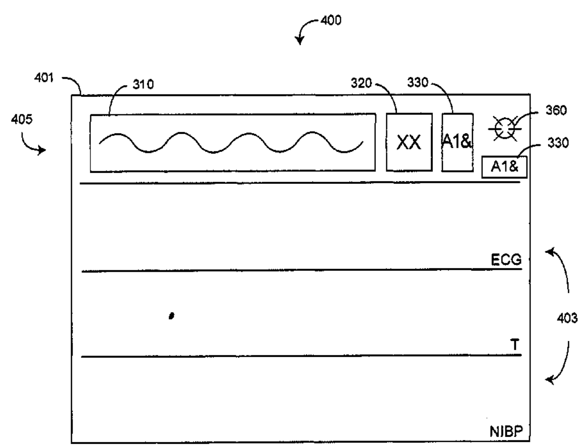
Primary Examiner — Kee M Tung
Assistant Examiner — Jwalant Amin
(74) *Attorney, Agent, or Firm* — Knobbe Martens Olson & Bear, LLP

(57) **ABSTRACT**

Display objects are defined that are capable of visually indicating physiological measurements and physiological monitor status. A virtual display utilizing these display objects is characterized by selecting those display objects corresponding to one or more particular physiological parameters, organizing the selected display objects within a virtual display area corresponding to at least a portion of a physical display, and associating data objects corresponding to the one or more physiological parameters with the selected display objects.

22 Claims, 5 Drawing Sheets



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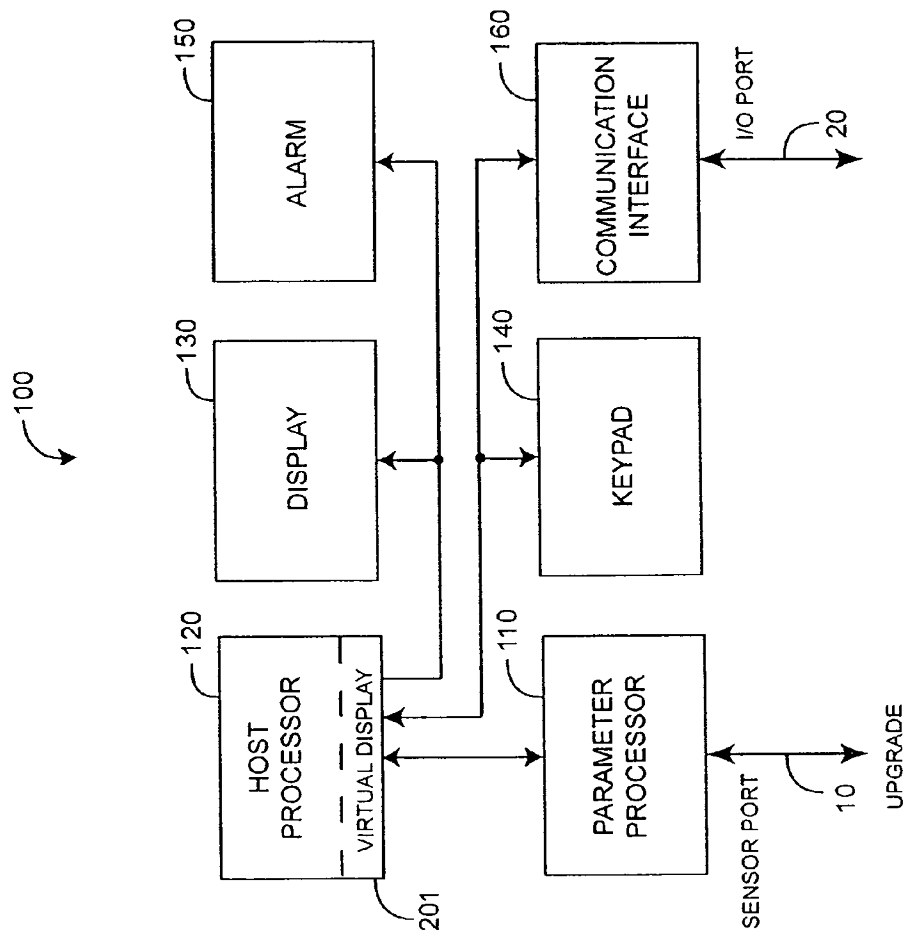
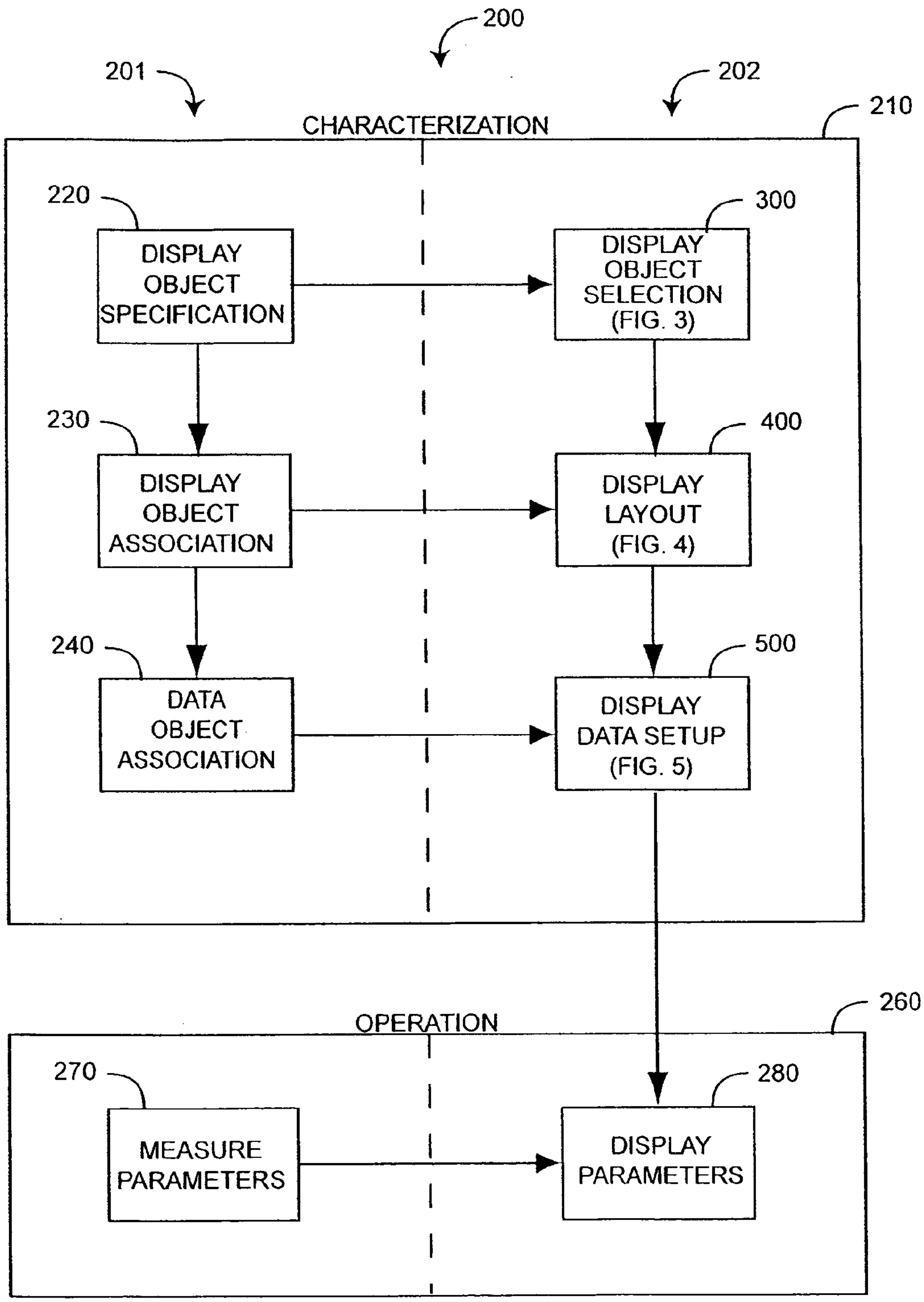

100
150
ALARM
130
DISPLAY
120
HOST PROCESSOR
VIRTUAL DISPLAY
201
160
COMMUNICATION INTERFACE
I/O PORT
20
140
KEYPAD
110
PARAMETER PROCESSOR
SENSOR PORT
10
UPGRADE

FIG. 1


200
201
202
210
CHARACTERIZATION
220
DISPLAY OBJECT SPECIFICATION
300
DISPLAY OBJECT SELECTION (FIG. 3)
230
DISPLAY OBJECT ASSOCIATION
400
DISPLAY LAYOUT (FIG. 4)
240
DATA OBJECT ASSOCIATION
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DISPLAY DATA SETUP (FIG. 5)
260
OPERATION
270
MEASURE PARAMETERS
280
DISPLAY PARAMETERS

FIG. 2

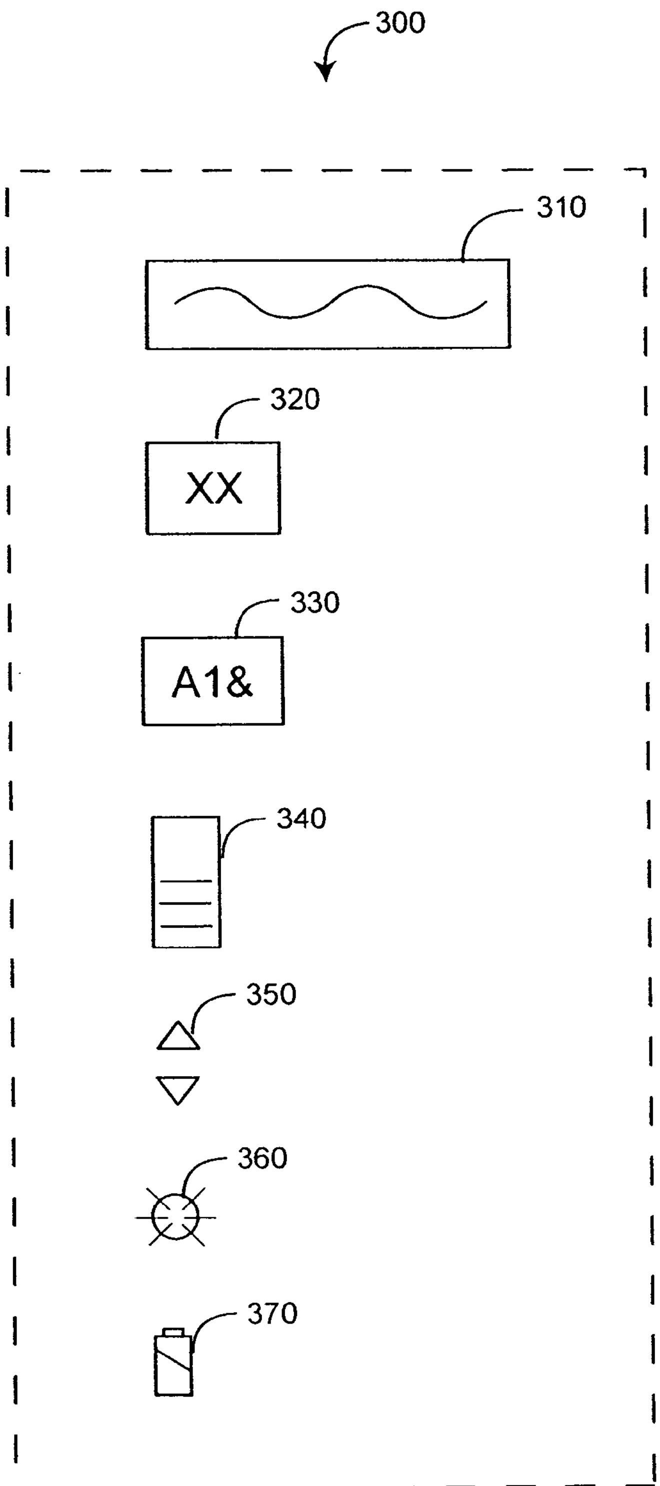

FIG. 3

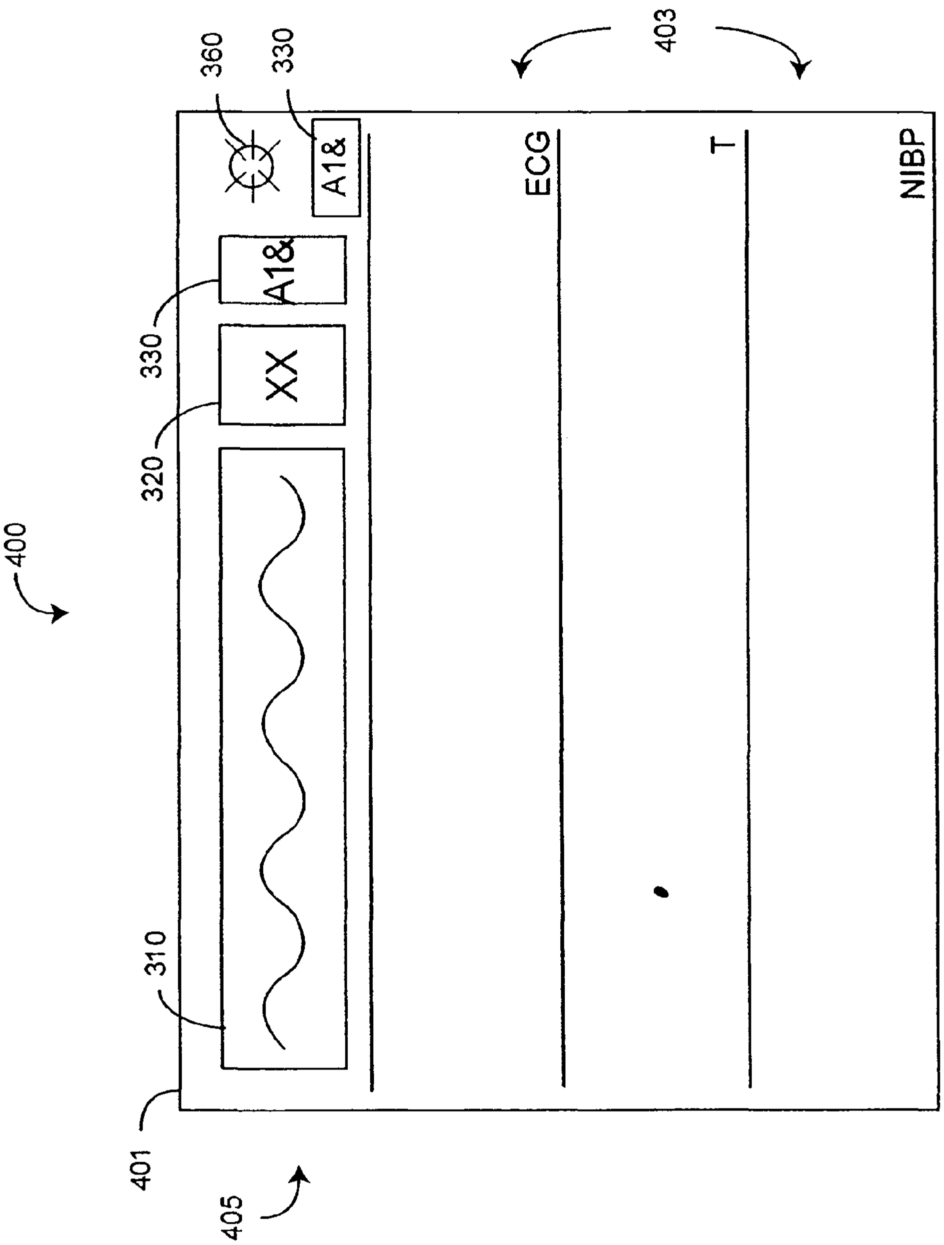

FIG. 4

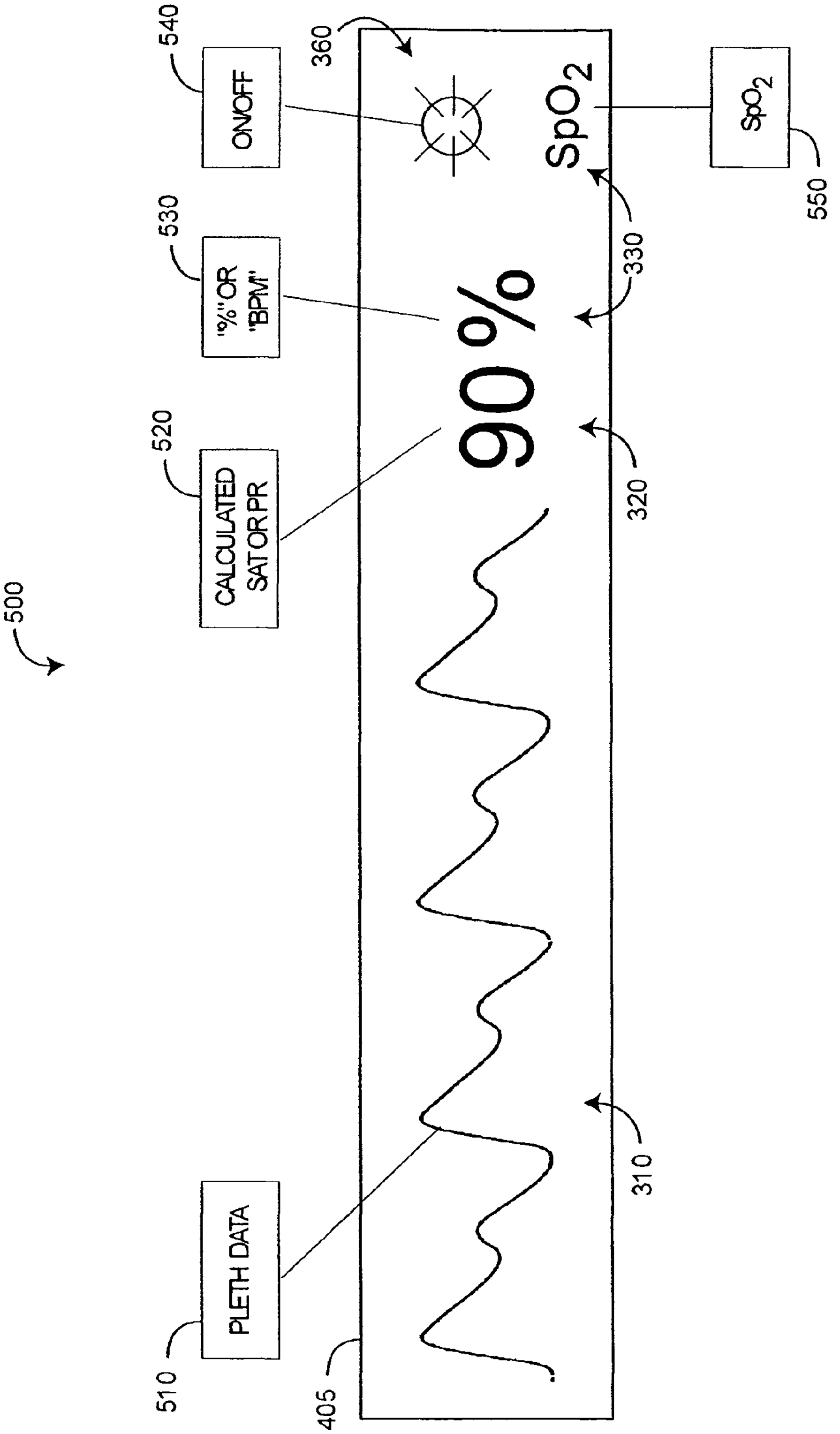
500
510
PLETH DATA
520
CALCULATED SAT OR PR
530
"%" OR "BPM"
540
ON/OFF
550
SpO_2
405
310
320
330
360
90%
SpO_2

FIG. 5

VIRTUAL DISPLAY

PRIORITY CLAIM TO RELATED PROVISIONAL APPLICATIONS

The present application claims priority benefit under 35 U.S.C. §119(e) to U.S. Provisional Patent Application Ser. No. 60/755,899, filed Jan. 3, 2006, entitled "Virtual Display." The present application incorporates the foregoing disclosure herein by reference.

BACKGROUND OF THE INVENTION

A conventional multiple parameter measurement system (MPMS) has a parameter processor and a host processor. The parameter processor may be an OEM board or plug-in that connects to and drives a sensor and computes one or more physiological parameters from the resulting sensor signal. The host processor communicates with the parameter processor so as to receive and display these parameters. As examples, a MPMS may display arterial oxygen saturation (SpO2), pulse rate, ECG waveforms, blood pressure and body temperature, to name a few.

SUMMARY OF THE INVENTION

A conventional MPMS typically requires hardware or software modifications in order to measure and display a new and useful parameter, such as a physiological measurement resulting from a technological advance. A virtual display advantageously generates a display for a previously undefined, unmeasurable or unknown measurement without complex system modifications. In one embodiment, a virtual display can be flexibly characterized so that a MPMS that is upgraded to measure a new parameter can readily display that parameter.

One aspect of a virtual display defines display objects capable of visually indicating physiological measurements and physiological monitor status. A subset of the display objects corresponding to a physiological parameter is selected. The selected display objects are organized within a virtual display area corresponding to at least a portion of a physical display. Data objects corresponding to the physiological parameter are associated with the selected display objects.

Another aspect of a virtual display is a physiological parameter measurement system comprising a virtual display, a parameter processor and a host processor. The parameter processor is adapted to input a sensor signal and output a physiological parameter responsive to the sensor signal. The host processor is in communication with said parameter processor, and the virtual display resides in the host processor. The parameter processor has a characterization for the virtual display that corresponds to the physiological parameter. That characterization is communicated to the host processor so as to enable the host processor to display the physiological parameter.

A further aspect of a virtual display comprises a virtual display area, a display object, a display layout and a data setup. The virtual display area corresponds to at least a portion of a physical display. The display objects are allocated to the display area. A display layout specifies at least the size and location of the display objects within the virtual display area, and a data setup associates the data objects with the display objects. The display objects are selected to visually indicate measurements of one or more particular physiological parameters on the physical display. The data objects identify measurements of the physiological parameters and information associated with the measurements.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of a multi-parameter measurement system (MPMS) incorporating a virtual display;

FIG. **2** is a flow diagram for a virtual display;

FIG. **3** is an illustration of exemplar display objects;

FIG. **4** is an illustration of an exemplar display layout utilizing selected display objects; and

FIG. **5** is an illustration of an exemplar display data setup.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. **1** illustrates a multi-parameter measurement system **100** (MPMS) configured with a virtual display. The MPMS comprises a parameter processor **110** and associated sensor port **10**, a host processor **120** and a display **130**. The parameter processor **110** is configured to receive signal processing and sensor control upgrades so that the parameter processor **110** is able to interface with new or upgraded sensors and able to measure previously undefined, unmeasurable or unknown, i.e. "new" physiological parameters. In one embodiment, the MPMS **100** is upgraded via the sensor port **10**. A sensor port upgrade capability is described in U.S. Pat. Pub. No. 2005/0075548, entitled Multipurpose Sensor Port, assigned to Masimo Corporation, Irvine, Calif. and incorporated by reference herein. In another embodiment, the parameter processor **110** is a plug-in containing a new parameter measurement capability that is inserted into the MPMS **100**.

As shown in FIG. **1**, the MPMS **100** advantageously incorporates a virtual display **201** that enables the MPMS **100** to readily display a new physiological parameter. In particular, the virtual display **201** resides on the host processor **120**. A parameter upgrade loaded into the parameter processor **110** provides information in a predetermined format that characterizes the virtual display **201**, i.e. describes how the MPMS **100** should display a new physiological parameter. The MPMS **100** may also have a keypad **140**, an alarm **150**, communications **160** and an associated I/O port **20** that provide status to the virtual display **201** according to the parameter upgrade. A virtual display **201** is described in detail with respect to FIG. **2**, below.

FIG. **2** illustrates virtual display functions **200**, which are divided between parameter processor functions **201** and host processor functions **202** and also between characterization functions **210** and operation functions **260**. During characterization **210**, the parameter processor **110** (FIG. **1**) prepares the host processor **120** (FIG. **1**) to display one or more new parameters. During operation **260**, the parameter processor **110** (FIG. **1**) provides the new parameter or parameters to the host processor **120** (FIG. **1**) for display according to the prior characterization. In one embodiment, the virtual display characterization **210** determines how data is to be displayed, such as a waveform, a bar graph or a numeric readout; how the display is organized, such as the size and layout of readouts and labels on a physical display space; and which data goes where on the display. Then, during operation **260**, the parameter processor provides measurement data for the virtual display **201**, and the host processor **120** (FIG. **1**) communicates the virtual display **201** to the physical display **130**.

As shown in FIG. **2**, characterization **210** includes the parameter processor functions **201** of display object specification **220**, display object association **230** and data object association **240**. Display objects are display mechanisms or formats used to present parameter measurements and processor status on a display **130** (FIG. **1**). Display objects may include, for example, various graphs, alphanumeric readouts and visual indicators. The display object specification **220** informs the host instrument which of various predefined display objects will be used to display one or more new parameters and corresponding monitor status.

The display object association **230** informs the host instrument of a desired organizational schema for the display objects, i.e. the spatial relationships and any other correspondence between the various display objects on the display. For instance, the host processor may need to locate an alphanumeric object immediately adjacent to a graphical object in order to display a waveform and a corresponding label identifying the waveform.

The data object association **240** informs the host instrument of the various data types, how those data types are to be recognized by the host instrument, and which data types are associated with which previously specified display objects. For example, plethysmograph data output from the parameter processor may map to a specific graphical display object.

Further shown in FIG. **2**, characterization **210** also includes the host processor functions **202** of display object selection **300**, display layout **400** and display data setup **500**, which correspond to the parameter processor functions **201** described above. Display object selection **300** is a response to display object specification **220**. In particular, the host processor selects one or more predefined display objects that the display object specification **220** identifies for use in a newly configured display.

FIG. **3** illustrates various display objects **300** including, as examples, a waveform magnitude vs. time graph **310**, a numeric readout **320**, an alphanumeric label **330**, a bar graph **340**, trend indicators **350**, a visual alarm **360** and a battery charge indicator **370**. One of ordinary skill in the art will recognize many other possible display objects useful for visually indicating, for example, physiological measurements and monitor status.

As shown in FIG. **2**, display layout **400** is a host processor response to display object association **230**. In particular, the host processor organizes selected display objects, such as described with respect to FIG. **3**, above, within a virtual display area. The virtual display area may correspond to an entire physical display or a newly allocated portion of a physical display utilized for simultaneous monitoring of multiple physiological parameters. In particular, the host processor utilizes known characteristics of the selected display objects along with the organizational schema provided by the display object association **230** to generate a layout for a newly defined display.

FIG. **4** illustrates an example of a display layout **400** having a virtual display area **401**, a first display area portion **403** allocated for previously defined parameters, such as ECG, temperature (T) and noninvasive blood pressure (NIBP) in this example, and a second display area portion **405** allocated for newly defined parameters. The display layout **400** locates and organizes selected display objects **300** (FIG. **3**) including a waveform graph object **310**, a numeric readout object **320**, two label objects **330** and an visual alarm object **360** within the second display portion **405**. In particular, the display layout **400** responds to the display object association **230** constraints that a first label **330** is adjacent and to the right of the numeric readout **320** and a second label **330** is adjacent and below the visual alarm **360**. Other constraints may include the relative size and location of the waveform object **310**. The functionality of the resulting display layout **400** is described further with respect to FIG. **5**, below.

Additionally shown in FIG. **2**, display data setup **500** is a response to data object association **240**. In particular, the host processor associates parameter processor identified input data with particular display objects located within the allocated display area **403** (FIG. **4**). Input data may be identified according to a physical input port or a data header or similar code within a data stream, or both.

FIG. **5** illustrates one example of a display data setup **500** having various data objects **510-550** associated with various display objects **310-360** within a display area **405**, so as to form an operational virtual display **201** (FIG. **1**). During operation, data comprising measured parameters from the parameter processor and possibly status or other data from the parameter processor **110** (FIG. **1**), host processor **120** (FIG. **1**), keypad **140** (FIG. **1**) or communication interface **160** (FIG. **1**) is transferred to the display objects **310-360** of the virtual display **201** (FIG. **1**). The virtual display **201** (FIG. **1**) is then communicated to the physical display **130** (FIG. **1**), as described above. In this particular example, a plethysmograph data object **510** is associated with the waveform object **310**; a calculated saturation or pulse rate data object **520** is associated with a numeric readout object **320**; a "%" or "BPM" text object **530** is associated with a first label object **330**; a "SpO2" text object is associated with a second label object **330** and an on/off command object **540** is associated with a visual alarm object **540**. The result is an operational pulse oximetry display.

Although a virtual display is described above with respect to a MPMS having a parameter processor and a host processor, in another embodiment, a physiological measurement system comprises a signal processor that functions as both a parameter processor and a host processor, as described above, with the signal processor incorporating a virtual display. A virtual display has been disclosed in detail in connection with various embodiments. These embodiments are disclosed by way of examples only and are not to limit the scope of the claims that follow. One of ordinary skill in art will appreciate many variations and modifications.

What is claimed is:

1. A display method comprising:

defining a plurality of display objects in a patient monitor configured to visually indicate at least one measurement of at least one physiological parameter, wherein the at least one measurement is determined using sensor signals received via a sensor port;

organizing the plurality of display objects within a virtual display area corresponding to at least a portion of a physical display to create a first display layout;

communicatively coupling a sensor to the sensor port;

receiving a display upgrade object through the sensor port, wherein the display upgrade object is different from the sensor signals;

associating at least one display object from the plurality of display objects with an additional physiological parameter previously undefined by the patient monitor in accordance with the display upgrade object;

organizing the at least one display object within the virtual display area in accordance with the display upgrade object to create a second display layout;

associating a plurality of data objects corresponding to the additional physiological parameter with the at least one display object;

determining whether the sensor is capable of measuring the additional physiological parameter characterized by the display upgrade object; and

upon determining that the sensor is capable of measuring the additional physiological parameter, automatically altering the virtual display based at least in part on the first display layout and the second display layout.

2. The display method according to claim 1, further comprising:

measuring the first physiological parameter;

associating the measurements with the data objects so as to generate a virtual display; and

communicating the virtual display to the physical display.

3. The display method according to claim 2, wherein the defining comprises:

defining measurement display objects comprising at least one of magnitude versus time graphs, bar graphs, magnitude versus frequency graphs, numerical readouts, alphanumeric labels, trend indicators and visual alarm indicators; and

defining monitor status display objects comprising at least one of power on/off indicators, low battery indicators, malfunction indicators.

4. The display method according to claim 1, wherein the organizing comprises:

spatially associating a first portion of the selected display objects with a second portion of the selected display objects within the virtual display area; and

determining the relative size of the display objects within the virtual display area.

5. The display method according to claim 1, wherein the display upgrade object is received from a personal computer interfaced to the sensor port.

6. The display method according to claim 1, wherein the display upgrade object comprises information associating at least one of the display objects to the physiological parameter.

7. A physiological parameter measurement system comprising:

a parameter processor configured to receive a sensor signal from a sensor and output at least a measurement of a first physiological parameter responsive to the sensor signal;

a host processor in communication with the parameter processor;

a virtual display residing in the host processor; and

a first characterization for the virtual display residing in the parameter processor, wherein

the first characterization is communicated to the host processor so as to enable the host processor to display the first physiological parameter,

the parameter processor is further configured to:

receive a parameter upgrade through a sensor port enabling the parameter processor to output at least a measurement of a second physiological parameter not previously displayed, wherein the parameter upgrade differs from the sensor signal and comprises a second characterization for the virtual display, and

determine whether the sensor is capable of measuring the second physiological parameter; and

upon determining that the sensor is capable of measuring the second physiological parameter, automatically alter the virtual display based at least in part on the first characterization and the second characterization.

8. The physiological parameter measurement system according to claim 7, wherein the virtual display comprises a plurality of display objects and a virtual display area.

9. The physiological parameter measurement system according to claim 8, wherein the first characterization comprises a first display schema for selecting the display objects and organizing the selected display objects within the virtual display area.

10. The physiological parameter measurement system according to claim 9, wherein the first characterization further comprises a mapping schema for associating data objects corresponding to the first physiological parameter with the selected display objects.

11. The physiological parameter measurement system according to claim 10, wherein the display objects comprise numerical readouts, alphanumeric labels, graphs, arrows, visual alarms and status indicators.

12. The physiological parameter measurement system according to claim 11, wherein the data objects identify data types comprising numerical values, alphanumeric values, waveforms, magnitudes, trends and alarms.

13. The physiological parameter measurement system according to claim 8, wherein the parameter upgrade is compiled in the parameter processor.

14. The physiological parameter measurement system according to claim 8, wherein the second characterization comprises a second display schema for selecting the display objects and organizing the selected display objects within the virtual display area.

15. The physiological parameter measurement system according to claim 14, wherein the second characterization further comprises a mapping schema for associating data objects corresponding to the second physiological parameter with the selected display objects.

16. The display method of claim 7, wherein the second physiological parameter is previously unknown by the physiological parameter measurement system.

17. A virtual display comprising:

a virtual display area corresponding to at least a portion of a physical display;

a plurality of display objects allocated to the virtual display area;

a first display layout specifying at least the size and location of the display objects within the virtual display area for a first physiological parameter; and

a first data setup associating a plurality of data objects with the plurality of display objects for the first physiological parameter, wherein

at least one display object from the plurality of display objects is selected to visually indicate measurements of the first physiological parameter on the physical display,

at least one data object from the plurality of data objects identifies the measurements and information corresponding to the measurements,

a second display layout and a second data setup for a second physiological parameter can be added via a display upgrade object received through a sensor port, wherein the second physiological parameter is unknown to the virtual display prior to receipt of the display upgrade object and the sensor port is further configured to receive sensor signals from a sensor indicative of a physiological parameter different from the display upgrade object, and

the virtual display is configured to:

determine whether the sensor is capable of measuring the second physiological parameter; and

upon determining that the sensor is capable of measuring the second physiological parameter, automatically alter the virtual display area based at least in part on the first display layout and the first data setup and the second display layout and second data setup.

18. The virtual display of claim 17, wherein the display upgrade object comprises at least one of the plurality of display objects selected to visually indicate measurements of a second physiological parameter on the display.

19. A display method comprising:

receiving a parameter upgrade through a sensor port of a multi-parameter measurement system, wherein the multi-parameter measurement system includes a plurality display of objects associated with one or more physiological parameters, the display objects being configured to visually indicate one or more measurements of the one or more physiological parameters according to at least a first display layout;

associating at least one display object from the plurality of display objects with an additional physiological parameter in accordance with the parameter upgrade, the at least one display object being configured to visually indicate at least one measurement of the additional physiological parameter, wherein the measurement is determined using sensor signals received from a sensor via the sensor port;

organizing the at least one display object within a virtual display area corresponding to at least a portion of a physical display of the multi-parameter measurement system in accordance with the parameter upgrade to create a second display layout;

associating at least one data object from a plurality of data objects corresponding to the physiological parameter with the least one display object in accordance with the parameter upgrade;

determining whether the sensor is capable of measuring the additional physiological parameter; and

upon determining that the sensor is capable of measuring the additional physiological parameter, automatically altering the virtual display based at least in part on the first display layout and the second display layout.

20. The display method of claim **19**, wherein the physiological parameter is previously unknown by the multi-parameter measurement system.

21. A physiological parameter measurement system comprising:

a sensor port in communication with a digital signal processor and configured to receive sensor signals from a sensor and further configured to receive a parameter upgrade, wherein the digital signal processor is configured to determine at least a measurement of a first physiological parameter using the sensor signals received at the sensor port;

a virtual display comprising a plurality of display objects; and

a first characterization associated with the first physiological parameter, wherein

the virtual display is configured to associate at least at least one of the plurality of display objects with a physical display according to the first characterization

the parameter upgrade comprises a second characterization associated with a second physiological parameter, wherein the virtual display is further configured to associate at least one of the plurality of display objects with the physical display according to the second characterization, and

the digital signal processor is further configured to:

determine whether the sensor is capable of measuring the second physiological parameter; and

upon determining that the sensor is capable of measuring the second physiological parameter, automatically alter the virtual display based at least in part on the first characterization and the second characterization.

22. The display method of claim **21**, wherein the second physiological parameter is previously unknown by the physiological parameter measurement system.

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